

A **Curved Fresnel Prism** would concentrate and spectrally disperse sunlight onto adjacent strings of solar photovoltaic cells, each string optimized for the part of the spectrum incident upon it.

strings together in parallel to maximize the output current of the array.

According to the original rainbow photovoltaic concept, the concentrated sunlight was to be split into multiple beams by use of an array of dichroic filters designed so that each beam would contain light in one of the desired wavelength bands. The concept has since been modified to provide for dispersion of the spectrum by use of adjacent prisms. A proposal for an advanced version calls for a unitary concentrator/spectral-beam-splitter optic in the form of a parabolic curved Fresnel-like

prism array with panels of photovoltaic cells on two sides (see figure). The surface supporting the solar cells can be adjusted in length or angle to accommodate the incident spectral pattern.

An unoptimized prototype assembly containing ten adjacent prisms and three photovoltaic cells with different bandgaps (InGaP₂, GaAs, and InGaAs) was constructed to demonstrate feasibility. The actual array will consist of a lightweight thin-film silicon layer of prisms curved into a parabolic shape. In an initial test under illumination of 1 sun at

zero airmass, the energy-conversion efficiency of the assembly was found to be 20 percent. Further analysis of the data from this test led to a projected energy-conversion efficiency as high as 41 percent for an array of 6 cells or strings (GaP, AlGaAs, InGaP₂, GaAs, and two different InGaAs cells or strings).

This work was done by Nick Mardesich and Virgil Shields of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-21051

Metal Side Reflectors for Trapping Light in QWIPs

Quantum efficiency would be increased because light would make multiple passes.

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Focal-plane arrays of quantum-well infrared photodetectors (QWIPs) equipped with both light-coupling diffraction gratings and metal side reflectors have been proposed, and prototypes are expected to be fabricated soon. The purpose served by the metal side reflectors is to increase quantum efficiency by helping to trap light in the photosensitive material of each pixel.

The reasons for using diffraction gratings were discussed in several prior NASA Tech Briefs articles. To recapitulate: In an array of QWIPs, the quantum-well layers are typically oriented parallel to the focal plane and therefore perpendicular or nearly perpendicular to the direction of incidence of infrared light. By virtue of the applicable quantum selection rules, light polarized parallel to the focal plane (as normally incident light is) cannot excite

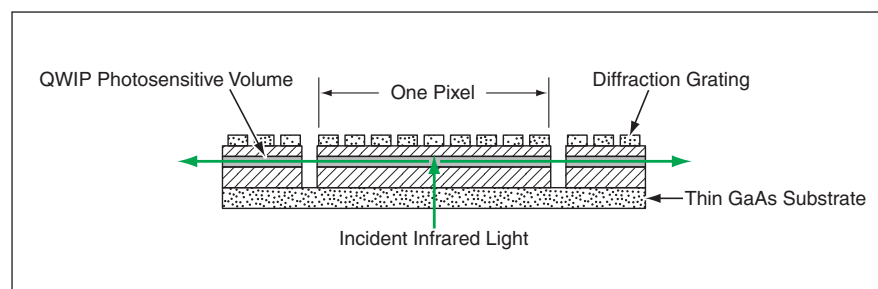


Figure 1. **Light Is Diffracted** almost parallel to the focal plane for maximum quantum efficiency in a QWIP of typical prior design. However, in the absence of reflectors like those shown in Figure 2, much of the diffracted light is lost from the QWIP of a given pixel after a single pass through the photosensitive QWIP volume.

charge carriers and, hence, cannot be detected. Diffraction gratings scatter normally or nearly normally incident light into directions more nearly parallel to the focal plane, so that a significant portion of the light attains a component of polarization normal to the focal plane and, hence, can

excite charge carriers. Unfortunately, light scattered in directions parallel or nearly parallel to the focal plane can escape sideways from the QWIP of a given pixel, as illustrated in Figure 1. The escaped light has made only a single pass through the interior photosensitive volume of the QWIP.

The quantum efficiency of the QWIP would be increased by trapping light so that it makes multiple passes through the photosensitive volume. As

shown in Figure 2, the sides of the QWIP of each pixel would be coated with gold to reflect escaping light back into the interior.

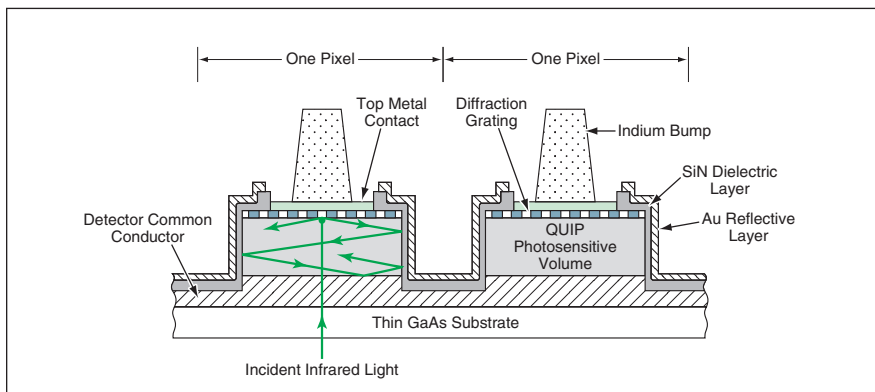


Figure 2. **Reflective Layers of Gold** in a QWIP array of the type now under development would make the light traverse the interior of each QWIP multiple times.

This work was done by Sarath Gunapala, Sumith Bandara, John Liu, and David Ting of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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